

SPECIAL POINTS OF INTEREST:

- Research News
- Grants awarded
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- Publications

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Improving poultry skeletal health

Skeletal disorders are common in commercial meat (broiler) and egg-laying poultry due to selection for fast growth and daily egg production. Leg bone disorders are particularly concerning as they cause pain, difficulty in walking, and economic loss. Abnormalities and architectural deterioration of bone can be caused or exacerbated by a number of factors, including heat stress. Probiotics (i.e., beneficial live microorganisms) have shown promise in improving bone health in human and rodent studies, but their effect on bone health in poultry has not been well explored. Dr Feifei Yan's PhD studies investigated the effect of probiotics on skeletal health of chickens under both normal and elevated temperatures. Bone mineral densities of the tibia and femur were improved in broilers and laying hens following dietary supplementation with probiotics. Broilers consuming a multi-species-based probiotic had a lower incidence of lameness and stronger legs measured by seeing how long they took to lie down when placed standing into an experimental arena (pictured). At high temperatures, probiotic-fed broilers had larger bones and higher bone mineral content of the tibia and femur.



They also had reduced plasma concentrations of TNF- α , a cytokine or cell-signaling protein, which promotes an inflammatory response to harmful stimuli. Overall, probiotics were found to enhance intestinal absorption of nutrients important to bone health, such as calcium, and reduce sympathetic activity thus improving mineralization of bone and inhibition of bone resorption. The results suggest that dietary supplementation with probiotics may be a successful strategy for improving leg bone health in poultry under both normal and elevated temperatures.

Alternatives to antibiotics after weaning and transport stress

Weaning, transport, and thermal stress have the potential to increase disease incidence and reduce animal welfare, especially when they occur concomitantly. To combat the negative effects of weaning and transport stress on piglet health and well-being, current management practices call for dietary inclusion of antibiotics. However, due to the recent 2017 Veterinary Feed Directive, many traditionally used dietary antibiotics can no longer be used putting the health and welfare of newly weaned and transported pigs at risk. To address this issue, we have performed two studies in a controlled environment and production environment comparing the use of L-glutamine (fed at 0.20% of the diet) as a replacement for traditional



dietary antibiotics (CTC + tiamulin) following weaning and transport in newly weaned pigs. In the controlled environment, pigs provided L-glutamine had an improvement in performance compared to those provided either antibiotics or no antibiotics. In a production environment when compared to pigs provided no antibiotics, those given either L-glutamine or traditional dietary antibiotics grew faster, ate more, and had a 2-fold reduction in their requirements for additional therapeutic antibiotic injections. These data suggest that providing L-glutamine at 0.20% of the diet following weaning and transport can improve piglet health and well-being similarly to traditional dietary antibiotic treatments.

Recent Awards

LBRU graduate students have continued our tradition of excellence and have had an exceptional year collecting awards!



Morgan Garvey received the Purdue Agriculture Graduate Student Pathmaker Award, given to two students (one M.S. and one Ph.D.) who have distinguished themselves as effective mentors by unselfishly investing in the success of undergraduate researchers-in-training and fellow graduate students. Morgan is on the Undergraduate Outreach Committee of the Black Graduate Student Association and further supports others through Purdue's Minorities in Agriculture Natural Resources and Related Sciences (MANRRS) student organization. She also has participated in a long list of community service projects on and off campus.

Nichole Chapel won a Purdue Animal Sciences Department LOUJA travel award in 2016 for her presentation titled, "Slow doesn't win the race: Reduced energy diets did not improve sow articular cartilage", which was presented at the American Society for Animal Science Joint Annual Meeting in July 2016.



She followed this up with the Department's 2016 Featherston Outstanding Graduate Teaching Award thanks to her multiple efforts across many Purdue ANSC courses, including the Animal Industry Travel Course. As part of this, Nichole spent a week on the road with 30 undergraduates, developed evaluation techniques, analyzed data, and presented the results of using social media as a tool to increase student involvement at the ASAS Innovate Conference.

Nichole then capped her achievements by winning the North American Colleges and Teachers of Agriculture (NACTA) Graduate Student Teaching Award at the organization's conference. This award recognizes and rewards graduate students who excel as teachers in the agricultural disciplines.



Chris Byrd won Purdue's 2017 Featherston Off-campus Training Fellowship. Chris obtained training from the Professional Animal Auditor Certification Organization (PAACO) on swine welfare and to complete his

certification, he had to take an online course and then travel to Michigan State University. He also won 3rd prize in the student poster competition at the North American Regional Meeting of the International Society for Applied Ethology.

Alan Duttlinger was a Purdue Animal Sciences Department 2017 LOUJA Award winner for his presentation "Replacing dietary antibiotics with 0.20% L-glutamine in swine nursery diets: Impact on health and productivity of pigs following weaning and transport during the summer." He traveled to the joint American and Canadian Societies for Animal Sciences meeting in Baltimore, MD this July.



Elizabeth Petrosus - won a Purdue Animal Sciences Department LOUJA travel award in 2016 for her presentation "The influence of orally administered norepinephrine and cortisol on the microbiome of weaned piglets."

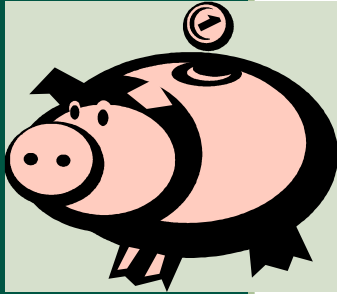
She also won the 2016 Featherston Outstanding M.S. Award based on the quality of her research and coursework, and her involvement in on-campus and off-campus activities.



The Featherston Outstanding Ph.D. Award for 2016 was awarded to **Feifei Yan**. Feifei completed her undergraduate career at Zhejiang University and her M.S. in ANSC with Dr. Cheng and stayed to work on her Ph.D. with Dr. Cheng. Her academic input has merited an authorship in nine peer-reviewed scientific publications, five of which have been published. Feifei has dedicated herself to animal science and desires to assist small farming practices in maximizing their efficiency. Her Ph.D. project is the "Effect of dietary supplementation of probiotics on skeletal health of poultry." The goals of her study were to examine perch access associated with the changes of physiological homeostasis; determine the development of osteoporosis and its associated pain; develop biomarkers for evaluating skeletal health in laying hens; and develop an alternative for controlling osteoporosis in laying hens.



"Award-winning
researchers"



Grants awarded

- **Cheng, H.W., Lay Jr., D.C.** and Erasmus, M. 2017-2020. Modification of the serotonergic system for controlling social aggression, feather pecking, and cannibalism in white leghorns. NIFA. \$500,000
- Erasmus, M. **Cheng, H.W.** 2017-2018. Effect of probiotics on social stress associated injurious pecking behavior in laying hens, PAWC. \$23,866
- Kim, B. **Cheng H.W.** 2017-2018. Mitigating the impact of heat stress in poultry: Effects of microbial probiotic supplementation on preventing heat stress-induced quality defects in broiler meat", AgSeed Purdue, \$50,000
- **Marchant-Forde, J.N.** 2017. Travel awards for scientists from developing countries to attend ISAE Congress *Open Philanthropy Project*. \$40,000.
- Rault, J.L., Morello, G.M., Morrison, R. and **Marchant-Forde, J.N.** 2016. Managing light and mat surface temperature in creep areas to promote piglet survivability *Pork CRC, Australia*. \$20,395.

Arrivals LBRU Welcomes....

Morgan Garvey is originally from Baytown, TX. She earned her BS in Animal Science from Tuskegee University in May of 2015. She joined the LBRU in September of 2016 as a Master's student under the direction of Dr. Susan Eicher. Morgan is working on probiotics and weaning stress in piglets.

Dr. Jackie Jacobs joined as a post-doctoral scientist in July 2016 to study the effect of probiotics on laying hen aggression. Jackie received her BS in Animal Science from the University of New Hampshire (2005) and worked as a veterinary technician for three years before pursuing graduate school. She earned her MS in Animal Behavior and Welfare from Michigan State University (2011) and her PhD in Epidemiology, Animal Behavior and Welfare from the University of Guelph (2016).

Ahmed Mohammed joined the LBRU in Feb 2016 as a visiting research scholar under the direction of Dr. Cheng. Ahmed obtained his BS and MS in veterinary sciences at Assiut University, Egypt, before coming to Purdue University to complete a PhD focused on the effect of heat stress on poultry behavior.

Rebecca Smith earned her BS in Animal Science from Purdue University in May of 2017. That same month she joined the LBRU as a Master's student under the direction of Dr. Donald Lay. Rebecca is

currently helping Dr. Lay finish up a piglet euthanasia project, studying the effects of nitrous oxide and carbon dioxide.

Alan Duttlinger joined the LBRU in June 2016 as a PhD student under the direction of Dr. Jay Johnson. As an Indiana native, Alan completed his BS at Purdue University in Animal Sciences and then pursued a MS at Kansas State University focused on swine nutrition. His current research focuses on transport and weaning stress in pigs and possible alternatives to antibiotics in swine diets.

Kouassi Kpodo joined the LBRU in May 2016 as a PhD student under Dr. Jay Johnson. He completed his BS and obtained his MS in Animal Sciences at the University of Tennessee Knoxville with a focus on heat stress and poultry nutrition. His current research focuses on impacts of heat stress and evaluation of heat stress recovery methods (gradual and rapid cooling) in swine.

Matthew Aardsma joined LBRU in Spring 2017 as a PhD student studying under Dr. Jay Johnson. Originally from Illinois, Matt completed both his BS and MS degrees at the University of Illinois at Champaign-Urbana. He is currently working on thermoregulation in broiler chickens and methods to access intestinal health in piglets following weaning and transport stresses.



Current personnel

Dr. Don C. Lay, Jr. - Research Leader

Dr. Heng-wei Cheng - Research Biologist

Dr. Susan D. Eicher - Research Physiologist

Dr. Jay S. Johnson - Research Animal Scientist

Dr. Jeremy N. Marchant-Forde - Research Animal Scientist

Dr. Jacquelyn Jacobs - Post-doctoral scientist

Dr. Severine Parois - Visiting post-doctoral scientist

Ahmed Mohammed - Visiting scholar

Stacey Enneking - Research Associate

Larla Moore - Program Support Assistant

Ryan Kilgore - Biological Science Technician

Elizabeth Petrosus - Biological Science Technician

Torey Raber - Biological Science Technician

Matthew Aardsma - Graduate Researcher

Chris Byrd - Graduate Researcher

Nichole Chapel - Graduate Researcher

Alan Duttlinger - Graduate Researcher

Morgan Garvey - Graduate Researcher

Jiaying Hu - Graduate Researcher

Xiaohong Huang - Graduate Researcher

Kouassi Kpodo - Graduate Researcher

Weichao Wang - Graduate Researcher

Rebecca Smith - Graduate Researcher

Jacob Richert - Undergraduate

Kelsey Clark - Undergraduate

Emily Gilley - Undergraduate

Alexis Weldon - Undergraduate

Paola Cruz - Summer Intern

Amelia Laub - Summer Intern

Cooling the farrowing sow....

Heat stress not only affects swine welfare, but is also estimated to cost the U.S. pork industry over \$360 million annually. Heat stress negatively impacts sow fertility and when heat stressed, lactating sows reduce their internal heat production by reducing their daily feed intake and milk production, which then also impacts piglet growth. To improve both welfare and productivity during hot conditions, some of the excess heat produced must be removed. Recently, in partnership with researchers in Purdue's Animal Sciences and Agricultural & Biological Engineering Departments, we designed a water-cooled floor pad to remove excess heat of lactating sows in high environmental temperatures and carried out an initial study to evaluate different water flow rates on the estimated amount of heat removal and reduction in the sow's responses to heat stress. We compared a constant cool water flow of 0.00 (CONTROL), 0.25 (LOW), 0.55 (MEDIUM) or 0.85 (HIGH) l/min for 90 minutes. The cooling was initiated 1 hour after the target room temperature of 35°C was reached. We found that all treat-

ments decreased respiration rate and rectal temperature. At the end of the



study period, the mean respiration rates were decreased by 33-77% relative to control sows. The rectal temperatures were decreased by 0.4-0.8°C relative to control. We concluded that our heat stress protocol did induce a heat stress response in the sows, and that the cooling pad worked to reduce this stress response, especially at the medium and high flow rates. The cooling pads have the potential to improve sow welfare and sow and piglet productivity during a heat stress event and further studies will be reported soon.

Departures....

With the graduation of his wife and our former MS student, Dr. Shelly DeBoer from Vet School, our research technician, **Bill DeBoer** has returned closer to their family home in Avon IN. Bill has also returned to his love of horticulture, working as a Production Manager and Food Safety Coordinator for Shenandoah Growers, producing living organic herbs.

After completing her PhD with Dr. Cheng, **Dr. Feifei Yan** has returned to China. Currently, Feifei is a lecturer and a faculty member of the Animal Welfare Institute, the College of Animal Science and Technology, Zhejiang Agricultural and Forestry University, China, where she is teaching in

animal welfare and research in poultry well-being.

Dr. Ediane Silva left in September 2016 taking a research position with Plum Island Animal Disease Center working on Foreign Animal Disease Research.

Kevin Shade, one of our undergraduate biological sciences aids, completed his studies at Purdue and left to start veterinary school at The Ohio State University in the Fall of 2016.

Jake Allrich another of our undergraduate biological sciences aids, graduated in May 2017 from Ag Engineering at Purdue and has started a position as an Operations Manager Trainee with Indiana Packers Corporation.

Kenzie Lucas left for a job as a Corrections Officer with the Tippecanoe County Sheriff's Department in November 2016.

Research technician **Tara Temkar** has left to pursue graduate school and has started a Master's in Public Health at Purdue University.

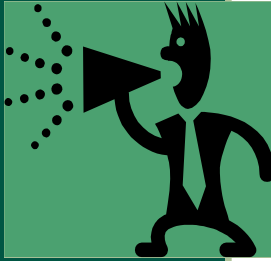
Chris Gonzales worked as a technician over the summer of 2017 and has left to start graduate school.

Jacob Richert was with us as an undergraduate biological sciences aids for 4 years and following his BS graduation, will move at the end of the summer to Kansas State University to start his MS degree in swine nutrition.



Goodbye!

Invites & media coverage



- Cheng, H.W.** (2016) The Future Poultry Welfare Development Trend in the United States - Cage-Free. Talk presented to researchers at Nanjing Agricultural University, China., June 2016.
- Cheng, H.W.** (2016) The effects of probiotics on welfare in layer hens. Talk presented to researchers at Zhejiang Agricultural and Forestry University, Zhejiang, China, July 2016.
- Cheng, H.W.** (2016) The effects of probiotic and synbiotic effect on poultry health. Talk presented to Novus International Inc. St Louis, MO. August 2016
- Cheng, H.W.** (2016) The cooled perch effects on hen health and welfare during heat stress. Talk presented to researchers at Zhejiang University, China, October 2016
- Eicher, S.D.** (2017) Interviewed for "Cow to cup" video designed to help students determine what they want to be when they grow up. Created for high school and early college career students to demonstrate the number of different career choices in the dairy industry by Purdue MS student Krystina Oates. It will be available online at Purdue Extension website.
- Marchant-Forde, J.N.** (2016) Swine production in the U.S. and the current research program at USDA-ARS, LBRU. Talk presented to researchers at the University of São Paulo – Pirassununga Campus, November 2016.
- Marchant-Forde, J.N.** (2016) Heart rate variability and the assessment of emotional state in animals. Measuring Animal Emotions Workshop – 50th Congress of the ISAE Satellite Meeting, July 12th, Edinburgh UK. (Poster)
- Marchant-Forde, J.N.** (2016) New indicators of animal welfare. 2nd International Workshop on Precision Environmental Control, Campinas, Brazil, November 2016.
- Marchant-Forde, J.N.** (2016) Future development of animal welfare science and use of new technologies. 4th Global Conference on Animal Welfare, Guadalajara, Mexico, December 2016.
- Marchant-Forde, J.N.** (2017) Welfare and enrichment of the laboratory pig. Science of Enrichment Symposium, University of Michigan – Unit for Laboratory Animal Medicine, Ann Arbor, MI, April 2017
- Marchant-Forde, J.N.** (2017) [Pig pens: a look at mirrors and mats.](#) *Morning AgClips.*
- Marchant-Forde, J.N.** (2017) [Pigs prefer to look at 'companions'.](#) *Feedstuffs.*
- Marchant-Forde, J.N.** (2017) [Improving pig accommodations with mirrors.](#) *Phys.org.*
- Marchant-Forde, J.N.** (2017) [Improving pig accommodations with mirrors.](#) *MTNV.*
- Marchant-Forde, J.N.** (2017) [Pig health starts in the pen.](#) *Food in Canada.*
- Marchant-Forde, J.N.** (2017) [No smoke, just mirrors.](#) *Farm Journal's PORK.*
- Marchant-Forde, J.N.** (2017) [Pig pens: A look at mirrors and mats.](#) *High Plains Journal.*
- Marchant-Forde, J.N.** (2017) [Pig pens: A look at mirrors and mats.](#) *Lancaster Farming.*

Conveyor belt for loading piglets

Pigs are not accustomed to climbing sloped ramps. However, sloped ramps are impossible to avoid in regular management and handling practices due to design of the physical facilities at finishing sites, packing plants, and the vehicles used to transport animals. Intense handling that may occur when there is not self-movement of pigs causes strain on animal handlers and can create a welfare problem for the pigs in question. Use of a conveyor belt can reduce the difficulty of loading animals.

This study examined the possibility of using a conveyor to move pigs up into a simulated top deck of a straight deck livestock trailer. Two age groups of pigs were tested, Weaned pigs and Nursery pigs. Weaned pigs were moved in groups of 20 while Nursery pigs were moved in groups of 10. Pigs used as a control treatment were herded up the ramp without the conveyor moving, thus keeping the flooring, width, and length the same for both treatments. Treatment pigs were moved using the



conveyor in-motion. Heart rate of two sentinel pigs per group, as well as the handler, was recorded during loading. The body temperature of the handler was recorded using infra-red thermography. Pigs were held in the simulated trailer for 30 minutes while heart rate was recorded. After which, they were unloaded and held in a holding pen for an additional 30 minutes while heart rate was again recorded. Based on behavior and physiology the pigs had similar

experiences in both treatments, thus conveying the pigs up into the trailer did not decrease their stress, nor did it increase it. Pigs being moved onto the moving conveyor did balk for a few more seconds than when the conveyor was not moving (Control pigs); but total time to load was the same. This study shows that it is feasible to use a conveyor to load pigs and is not detrimental, but it may not be advantageous either.

A tale of pigs' tails



Tail-docking of piglets, primarily to prevent damaging tail-biting occurring during the pigs' later life, continues to be an important topic, especially in the European Union, where routine docking is banned under EU legislation. The LBRU was



the only non-European participant in the EU-funded **FareWellDock** project, led by Prof. Anna Valros of the University of Helsinki. The research components were completed at the end of 2016, but the important work of technology transfer continues, as we aim to convert the newly-gained knowledge into information and practical advice that farmers can directly use on their farms. The project has produced 4 factsheets, entitled: **Tail docking and biting: painful consequences?**; **Enrichment for weaners and finishers**; **The role of health in tail biting**; and **How to spot early signs of tail biting**. All factsheets are available in 8 languages. The main FareWellDock website continues to be a go-to resource for everything on the topic, including relevant research being carried out by project

partners and other researchers together with industry information and discussion articles.

Dr. Marchant-Forde of the LBRU has also helped organize a one-day satellite meeting exploring the underlying mechanisms of tail-biting in pigs and feather-pecking in poultry, to be held in conjunction with the 51st Annual Congress of the International Society for Applied Ethology in Aarhus, Denmark in August 2017. The satellite meeting will be attended by 60 researchers from 25 countries, highlighting the international interest in the topic and the desire for cooperation and exchange of information.

FareWellDock Factsheet 3 (English)

The role of health in tail biting

Preventing health problems is good for both animal welfare and economy. Could it also help you avoid injurious tail biting outbreaks?



Previous knowledge

What does science say?

Tail biting is related to health in two ways:

Firstly, tail biting victims are at risk for developing infections due to bacteria entering through wounds in the tail. Activity, respiratory infection and internal diseases are all well-known consequences of tail biting. Victims of tail biting also show reduced growth. The infections and reduced growth will together lead to economic loss for producers due to reduced carcass weight and carcasses downgrading. In addition, tail biting, and its detrimental effects on health, has obvious negative consequences for the welfare of the tail bitten pigs.

Secondly, tail health on the farm level may be a risk factor for the development of an injurious tail biting outbreak. An increased risk for tail biting damage has been seen on farms with rectal prolapse and respiratory disease. Both leg disorders and respiratory inflammation has been found to be highly correlated with tail damage, but it is difficult to say which came first; the health problem or the tail biting. Thus, we need more knowledge to understand how health can contribute to a pig becoming a biter or a victim.



New insights from FareWellDock

The social behaviour of sick pigs differ from that of healthy penmates.

Pigs with osteochondritis receive more sniffing and tail bites from their penmates than healthy pigs, while

pigs with mild respiratory disease tend to bite more at the ears and tails of penmates than healthy pigs did.

Preliminary evidence suggests that low-grade inflammation may decrease activity and increase received sniffing and attacks by other pigs.

Actions

✓ Keep your pigs healthy, this will be good both for productivity and also help you avoid injurious tail biting outbreaks.

If pigs show signs of illness, be more alert to tail biting risk.

Remove tail bitten pigs promptly to avoid further damage and treat according to veterinary advice.

Further information

FareWellDock Website: www.farewelldock.eu



Visitors



Dr. Severine Parois joined as a Visiting Postdoctoral Research Scientist in Jan 2017 to study the effects of probiotics on pig's welfare and learning abilities, working with Dr. Jeremy Marchant-Forde. She completed a BS in Biology (2010), a French Graduate Engineering School in Agronomy, specialty in Livestock Science (2013) and her PhD in Biology and Agronomy in swine (2016) from Agrocampus Ouest (France).

Paola M. Cruz Ramos is an undergraduate student earning her BS in Animal Science/Pre-Vet from the University of Puerto Rico at Mayaguez. She will graduate in Decem-

ber 2017 and will continue to pursue a DVM/PhD. She is currently



rently a summer intern at USDA-ARS as a Livestock Lab Assistant with the hopes of learning a variety of lab techniques and participating in many different research projects on swine, poultry, and cattle.

Yanan Wu was a visiting PhD student in Dr. Cheng's lab and conducted "Environmental

management of cage and cage-alternative layer housing systems for thermal comfort and air quality". She has returned to China where she is a researcher at Cargill ONE Innovation Center, Shanghai, China.

We again hosted 6 students (**Yiru Dong, Huaxun Fang, Jiaqi Hu, Zeen Huang, Sichao Mao, and Ye Wu**) from Zhejiang University and 2 students (**Shih-Ting Huang and Ke Shan**) from Taiwan National University as part of Summer Research for Chinese Students program organized by Purdue University, with leadership from LBRU's Dr Heng-wei Cheng.

Recent publications



- Cabezón, F.A., Schinckel, A.P., Smith, A.J., **Marchant-Forde, J.N.**, **Johnson, J.S.** and Stwalley, R.M. (2017) Initial evaluation of floor cooling on lactating sows under severe acute heat stress. *Professional Animal Scientist* **33**: 254-260. doi:10.15232/pas.2016-01584
- Chen, H., **Yan, F.F.**, **Hu, J.Y.**, **Wu, Y.N.**, Tucker, C.M., Green, A.R., and **Cheng, H.W.** (2017) Immune response of laying hens exposed to 30 ppm ammonia for 25 weeks. *International Journal of Poultry Science* **16**: 139-146. doi:10.3923/ijps.2017.139.146
- Grenier, B., Dohnal, I., Shanmugasundaram, R., **Eicher, S.D.**, Selvaraj, R.K., Schatzmayr, G., Applegate, T.J. (2016) Susceptibility of broiler chickens to coccidiosis when fed subclinical doses of deoxynivalenol and fumonisins – special emphasis on the immunological response and the mycotoxin interaction. *Toxins* **8**: Article 231. doi:10.3390/toxins8080231
- Hu, J.Y.**, Dennis, R.L., Zhao, J.M., and **Cheng, H.W.** (2016) Effect of Dietary Supplementation of an Antioxidant Blend on Performance, Egg Quality and Behavior in Bovans Brown Hen *International Journal of Poultry Science* **15**: 192-200. doi:10.3923/ijps.2016.192.200
- Hu, J.Y.**, Hester, P.Y., Makagon, M.M., Vezzoli, G., Gates, R.S., Xiong, Y.J. and **Cheng, H.W.** (2016) Cooled perch effects on performance and well-being traits in caged White Leghorn hens. *Poultry Science* **95**: 2737-2746. doi:10.3382/ps/pew248
- Jacobs, J.A.**, Coe, J., Pearl, D.L., Widowski, T.M., Niel, L. (2017) Factors associated with canine resource guarding behavior in the presence of dogs: A cross-sectional survey of dog owners. *Prev. Vet. Med.* <http://dx.doi.org/10.1016/j.prevetmed.2017.02.004>
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- Jacobs, J.A.**, Pearl, D.L., Coe, J.B., Widowski, T.M. and Niel, L. (2017) Ability of owners to identify resource guarding behaviour in the domestic dog. *Applied Animal Behaviour Science* **188**: 77-83. doi:10.1016/j.applanim.2016.12.012
- Johnson, J.S.** and **Lay Jr., D.C.** (2017) Evaluating the behavior, growth performance, immune parameters, and intestinal morphology of weaned piglets after simulated transport and heat stress when antibiotics are eliminated from the diet or replaced with L-glutamine. *Journal of Animal Science* **95**: 91-102. doi:10.2527/jas.2016.1070
- Johnson, J.S.**, Martin, K.L., Pohler, K.G. and Stewart, K.R. (2016) Effects of rapid temperature fluctuations prior to breeding on reproductive efficiency in replacement gilts. *Journal of Thermal Biology* **61**: 29-37. doi:10.1016/j.jtherbio.2016.08.003
- Johnson, J.S.**, **Sapkota, A.** and **Lay Jr., D.C.** (2016) Rapid cooling after acute hyperthermia alters intestinal morphology and increases the systemic inflammatory response in pigs. *Journal of Applied Physiology* **120**: 1249-1259. doi:10.1152/japplphysiol.00685.2015
- Johnson, J.S.**, and **Shade K.A.** (2017) Characterizing body temperature and activity changes at the onset of estrus in replacement gilts. *Livestock Science* **199**: 22-24. doi:10.1016/j.livsci.2017.03.004
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- Kim, H.W., Miller, D.K., **Yan, F.F.**, **Wang, W.**, **Cheng, H.W.** and Kim, Y.H.B. (2017) Probiotic supplementation and fast freezing to improve quality attributes and oxidation stability of frozen chicken breast muscle. *LWT Food Science and Technology* **75**: 34-41. doi:10.1016/j.lwt.2016.08.035
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- Kvidera, S.K., Dickson, M.J., Abuajamieh, M., Snider, D.B., Sanz Fernandez, M.V., **Johnson, J.S.**, Keating, A.F., Gorden, R.J., Green, H.B., Schoenberg, K.M. and Baumgard, L.H. (2017) Intentionally reduced intestinal integrity causes inflammation and negatively affects metabolism and productivity in lactating Holstein cows. *Journal of Dairy Science* **100**: 4113-4127. doi:10.3168/jds.2016-12349
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Recent publications...continued



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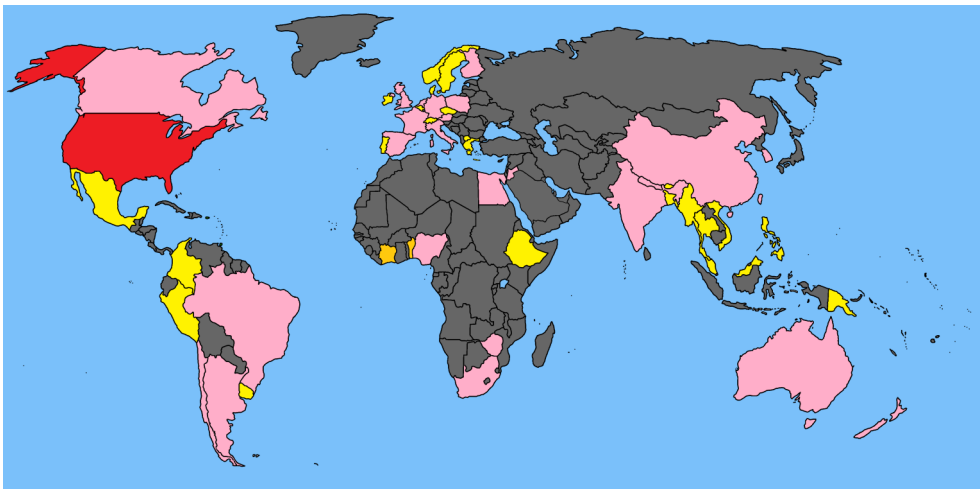
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Our global reach...

For those of us working in animal agriculture, we are often reminded of projected global population growth of about 2.5 billion people to 9.7 billion by 2050. There is also a projected increase in overall food demand and a per capita increase in demand for food from animal sources, especially in developing countries. With 1 billion people on the planet currently being food insecure, it might be considered that farm animal welfare is a societal concern only in countries with strong economies and plentiful food supply. This is not the case, and the scientific exchange and technology transfer across all continents is as strong in farm animal welfare as it is in other branches of animal science. Scientists in the LBRU have effective global links, embracing the diversity of ideas and research methods that comes with tackling similar problems with colleagues from other countries. The rewards of this approach are the production of better science, with greater impact, and the strengthening of relationships at individual, institutional and national levels. The LBRU publication list on page 7

covers only 15 months, but represents collaborations with scientists from 25 different countries (pink), based in North and South America, Africa, Asia, Europe and Oceania.

Together with direct research activity, LBRU scientists are also heavily involved in consulting, outreach and conference presentation and organization efforts, and with these interactions, our reach spreads to 50 countries (pink and yellow). These efforts enhance USDA-ARS's profile and exposes us to novel approaches which we can apply to our own research program and the transfer of our results to our stakeholders, ensuring that U.S. production maintains relevance and competitiveness in the global marketplace.



The 2017 AgDiscovery Program

*Hosting the next
generation of
agricultural scientists*

The LBRU was excited to host 15 students as part of the USDA's AgDiscovery program. AgDiscovery is a summer camp outreach designed to help high school students explore careers in animal science, veterinary medicine, agribusiness, plant pathology, aquaculture, and all things agricultural. The program allows participants to live on a college campus, and discover agricultural science from university professors, practicing veterinarians, industry representatives, and professionals working for the U.S. government.

New to the AgDiscovery program in 2017 was a joint partnership between Purdue's College of Agriculture and Purdue Veterinary Medicine, with input from all three USDA-ARS units based on campus - the LBRU, the National Soil Erosion Research Laboratory and the Crop Production and Pest Control Research Unit. The 2-week experience immersed the participants in various fields of study through a series of hands-on labs, workshops, and field trips, designed to give real-life experiences within the various aspects of Indiana agriculture and veterinary health care.



Our day with the students began with an overview of animal husbandry followed by a look at an ongoing study examining piglet cognition. They then got to try some swine handling first-hand, learning how the animal can be moved calmly by entering or leaving its flight zone in different directions. A trip to the Purdue Dairy Unit was followed by an overview of livestock animal welfare, why welfare is important, and how we can assess welfare in farm settings. Students then visited the Purdue Poultry Unit and evaluated the welfare of chickens in cages versus floor pens and compared gilts and sows housed indoors in individual pens versus in outdoor group pens at the Purdue Swine Unit. Using the welfare and husbandry principles they learned throughout the day, the students discussed which facilities provided better welfare for the 2 species. To wrap up the day, they worked in groups and developed reasons that supported their choices and presented their reasons to the entire group.

Early grouping of dairy calves

To determine the effect of age at grouping on behavior, health, and production of dairy bull calves, 90 Holstein-Friesian bull calves were housed in groups of 3 calves either from 3 days of age, from 7 days of age or from 14 days of age until they were 7 weeks old. Calves grouped at 3 days after birth spent more time playing and being socially interactive than calves grouped at 7 and 14 days. Calves engaged in social interaction as early as 3 days of age and social interactions between 3 to 6 weeks of age increased markedly. Calves grouped at 14 days vocalized more than did those grouped at day 7 or day 3. No difference was found between treatments in growth performance. Calf fecal, cough, nasal and ocular discharge scores, differential leukocyte (white blood cell) counts, and plasma cortisol (stress hormone) concentrations were not affected by age at grouping. However, during the first week



of grouping, when calves were moved from individual pens to group pens, some calves were unable to find their milk bottles and required guidance. In conclusion, these data show no adverse effects on health or performance and some benefits on social behavior for early (day 3) grouping of calves.

Dairy cow flooring

Cows on concrete flooring (vs. rubber) have classic immunological indicators of chronic pain; increased peripheral blood mononuclear cell numbers, more IL-1 β (inflammatory signal), and lower IL-1Ra (IL-1 receptor antagonist). We hypothesized that a profile of biomarkers on lymphocytes and monocytes could be associated with chronic pain. 1st-calf heifers were assigned to rubber or concrete flooring. On day 45 and 90 of the 1st lactation, and day -3, 7, 21, 45, and 90 of the 2nd lactation hematology and lymphocyte marker expression were analyzed. White blood counts were similar to our previous study, numbers and percentages of lymphocyte and monocytes were greater for cows on concrete than rubber, but only until day 21 of the 2nd lactation. Buffy coat cells were further stimulated with Substance-P (a neurotransmitter associated with pain) in vitro.

Cells were labeled to determine which type of white blood cells were affected by the flooring and by further



stimulation with the neurotransmitter. Many significant interactions were detected for lymphocytes. Intensity of CD4 and CD8 (markers of lymphocyte function), and a dendritic cell (antigen presenting cell) marker was most affected by the flooring, day, and Substance-P stimulation. Thus, the ability of immune cells to react to a pathogen or inflammation is affected by the cow's flooring. These results will help us to identify a minimally invasive way to determine housing conditions that may be reducing well-being of cattle.

One Health/One Welfare

"One Health" and "One Welfare" as defined phrases are relatively new, but as concepts date back many centuries. The common driver behind both of these concepts is that health and welfare of animals is intrinsically linked to the health and welfare of humans and the health and welfare of the global environment. Academic research often results in narrow focus on a single issue, but it is more apparent that real progress comes from interdisciplinary work and

the application of methods and ideas to areas not directly related to your immediate area of study. Much of the work of the LBRU aligns with the One Health /One Welfare concepts. As we focus on aspects of farm animal welfare, we are looking to improve animals' quality of life, improve their health, improve the animal/human relationship and improve the production of safe, healthy food, in a sustainable way.

Secondary to this direct approach, we are also engaged in interdisciplinary research closely aligned to human health. In recent years, we have



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been working with colleagues in the areas of kinesiology, industrial pharmacy and laboratory animal welfare. In these activities, we are bringing our farm animal welfare science expertise to projects aimed at ultimately understanding and improving human health and well-being. There is increasing interest in pigs as biomedical models for human disease and therapeutics, and we have been involved

in drug development studies and research examining the effects of exercise during gestation on cardiovascular health of offspring. Research on housing of pigs and mice as laboratory animals is aimed at improving the animals' welfare and also at refining experimental methods and the quality of data collected, thereby reducing animal use and potentially improving the translation of new chemical entities into therapeutic compounds for human use, improving human quality of life.



USDA-ARS-MWA

Livestock Behavior Research Unit

Poultry Science Building,
Purdue University,
125 S. Russell Street,
West Lafayette, IN 47907, USA

Phone: 765-494-4604

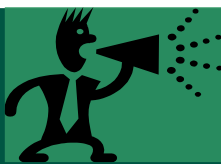
Fax: 765-496-1993

E-mail: larla.moore@ars.usda.gov

The mission of the Livestock Behavior Research Unit is to optimize animal welfare while assisting animal agriculture to meet ethical and political concerns of how we raise food-producing animals. We will develop scientific measures of animal welfare, through the study of animal behavior, physiology, nutrition, neuroscience and immunology; that will allow an objective evaluation of animal agricultural practices. This holistic method of study will allow the improvement of existing practices and invention of new practices that can enhance animal welfare and increase animal productivity. Successful completion of our mission will enable our goal of improving animal welfare for all stakeholders while ensuring economic sustainability for the animal production industries.

Finding solutions to agricultural challenges

USDA is an equal opportunity provider and employer.



Out & about - disseminating LBRU research

LBRU scientists attended and contributed to the following conferences:

- 9th Boehringer Ingelheim Expert Forum on Farm Animal Well-Being, Montreal, Canada, June 2016
- 50th Congress of the International Society for Applied Ethology, Edinburgh, UK, July 2016
- ASAS-ADSA-CSAS-WSASAS Joint Annual Meeting, Salt Lake City, UT, July 2016
- Poultry Science Association, 2016 PSA Annual Meeting, New Orleans, LA, July 2016
- International Veterinary Immunology Symposium, Gold Coast, Australia, August 2016
- 2nd International Workshop on Precision Environmental Control, Campinas, Brazil, November 2016.
- 4th OIE Global Conference on Animal Welfare, Guadalajara, Mexico, December 2016
- Conference of Research Workers in Animal Disease, December 2016.
- Midwest Section ASAS, Omaha, NE, March 2017
- Science of Enrichment Symposium, University of Michigan – Unit for Laboratory Animal Medicine, Ann Arbor, MI, April 2017
- Regional meeting of the U.S./Canada Regions of the International Society for Applied Ethology, Ames, IA, May 2017
- Center for Animal Welfare Science Symposium and workshop, Purdue University, May, 2017
- ASAS-CSAS Annual Meeting and Trade Show, Baltimore, July 2017